UNITED STATES OF AMERICA
BEFORE THE
FEDERAL ENERGY REGULATORY COMMISSION

Turlock Irrigation District	)	
	)	
and	)	Project No. 2299
	)	
Modesto Irrigation District	)	

2005 LOWER TUOLUMNE RIVER ANNUAL REPORT

Report 2005-5

Rotary Screw Trap Summary Update

Prepared by

Andrea Fuller

S. P. Cramer and Associates
Gresham, OR

LIST OF FIGURES

LIST OF TABLES

INTRODUCTION

Since 1995, rotary screw trap monitoring has been conducted annually near the mouth of the Tuolumne River to assess abundance and migration characteristics of juvenile Chinook salmon and other fishes. Trapping was conducted at the Shiloh Bridge (RM 3.4) from 1995 through 1998 by the Turlock and Modesto Irrigation Districts (Districts) and the California Department of Fish and Game (CDFG); and at Grayson (RM 5.2) from 1999 through 2003 by CDFG and from 2004 through 2005 by S.P. Cramer & Associates (SPC&A). This report summarizes results of the 1995 through 2005 trapping efforts (Table 1).

Available data for all years of sampling was compiled and summarized for this report, and a table noting the status of data availability was generated (Table 2). All 2004 and 2005 data was available from either a database or summary spreadsheets maintained by SPC&A. Electronically accessible data from CDFG is incomplete for all years prior to 2004. The only data available for all years sampled is daily Chinook catch and total estimated Chinook passage.

Table 1. Rotary screw trap monitoring in the Lower Tuolumne River at Shiloh (RM 3.4) and Grayson (RM 5.2), 1995-2005. Two traps were used in all years except 1998 when only a single trap was deployed.

Year	*Site*	*Period Sampled*	*Proportion of Outmigration Period Sampled*	*Total Catch*	*Total Estimated Passage*	*Results Reported In*
1995	Shiloh	Apr 25-Jun 01	24%	141	15,667	Heyne and Loudermilk 1997
1996	Shiloh	Apr 18 - May 29	27%	610	40,385	Heyne and Loudermilk 1997
1997	Shiloh	Apr 18 - May 24	24%	57	2,850	Heyne and Loudermilk 1998
1998	Shiloh	Feb 15 - Jul 01	70%	2,546	1,615,673	Blakeman 2004a
1999	Grayson	Jan 12 - Jun 06	93%	19,327	1,073,669	Vasques and Kundargi 2001
2000	Grayson	Jan 09 - Jun 12	95%	2,250	132,017	Vasques and Kundargi 2001
2001	Grayson	Jan 03 - May 29	97%	6,478	111,644	Vasques and Kundargi 2002
2002	Grayson	Jan 15 - Jun 06	91%	436	14,540	Blakeman 2004b
2003	Grayson	Apr 01 - Jun 06	40%	359	7,261	Blakeman 2004c
2004	Grayson	Apr 01 - Jun 09	40%	509	12,567	Fuller 2005
2005	Grayson	Apr 02 – Jun 17	39%	1,317	74,471	Fuller and others 2006

Table 2. Data collected and presently available for rotary screw trap sampling at Shiloh (RM 3.4) and Grayson (RM 5.2), 1995-2005.

Data Type	*1995*	*1996*	*1997*	*1998*	*1999*	*2000*	*2001*	*2002*	*2003*	*2004*	*2005*
Chinook Salmon											
Daily catch	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Daily average length	NP	NP	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Individual length	NP	NP	NP	Yes	Yes	Yes	Yes	Yes	NP	Yes	Yes
Daily est. passage	NP	NP	Yes	NP	NP	Yes	Yes	NP	NP	Yes	Yes
Total est. passage	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Smolt index	NP	NP	NP	Yes	Yes	Yes	Yes	Yes	NP	Yes	Yes
Other Species											
Daily catch	Yes	Yes	NP	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Individual length	NP	NP	NP	Yes	Yes	Yes	Yes	Yes	NP	Yes	Yes
Trap Efficiency											
Time of release	NP	NP	NP	NP	NP	NP	NP	NP	NP	Yes	Yes
Release location	NP	NP	NP	Yes	NP	NP	NP	NP	NP	Yes	Yes
Length at release	Yes	NP	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Length at recapture	NP	Yes	Yes	Yes	Yes	Yes	NP	NP	NP	Yes	Yes
Trap Operation And Environmental Information											
Trap status	NP	NP	NP	Yes	Yes	Yes	Yes	Yes	NP	Yes	Yes
Trap condition	NP	NP	NP	Yes	Yes	Yes	Yes	Yes	NP	Yes	Yes
Velocity	NP	NP	NP	Yes	NP	Yes	NP	NP	NP	Yes	Yes
Turbidity	X	X	X	Yes	Yes	Yes	Yes	Yes	NP	Yes	Yes

Key to codes:
Yes= Data was collected and obtained from CDFG or S.P. Cramer & Associates.
NP= Data was collected but not found in easily accessible sources (i.e., CDFG in annual reports, misc. spreadsheets, or on the Bay Delta and Tributaries website).
X= Data was not collected.

SUMMARY UPDATE

Juvenile Chinook Salmon

Juvenile Chinook Catch

Total annual catch of juvenile Chinook salmon has varied substantially between years (Table 1, Figure 1). This variation is likely due to differences in one or more factors including the duration and timing of the sampling periods, flow conditions, and overall fish abundance (Table 1, Figure 1).

Juvenile Chinook outmigration in the San Joaquin Basin typically occurs during the winter and spring, extending from January through May (Vasques and Kundargi 2001; SRFG 2004). The winter migration period is dominated by fry migrants that are typically less than 50 mm forklength, and the spring period is dominated by smolts which are typically greater than 70 mm forklength.

Sampling periods have varied between years with sampling initiated as early as January or as late as April and continuing through May/June. During 1999-2002, sampling encompassed the majority of the expected winter/spring outmigration season (i.e., January-May/June) and can be described as comprehensive (Figure 1 and Figure 2). In contrast, sampling was only conducted during the spring smolt outmigration period (i.e., April-May/June) in 1995-1997 and 2003-2005, so sampling was incomplete for these years. Sampling during 1998 began in February but was limited to a single trap (note: two traps were operated in all other years); thus, 1998 sampling covered an intermediate proportion of the entire outmigration period relative to all other years of monitoring.

Of the winter/spring sampling years, total trap catch at Grayson ranged from a high of 19,327 during 1999 to a low of 436 during 2002, and averaged 7,123 juvenile Chinook salmon (Figure 1). In all years of spring-only sampling, catches ranged from a high of 1,239 during 2001 to a low of 57 during 1997.

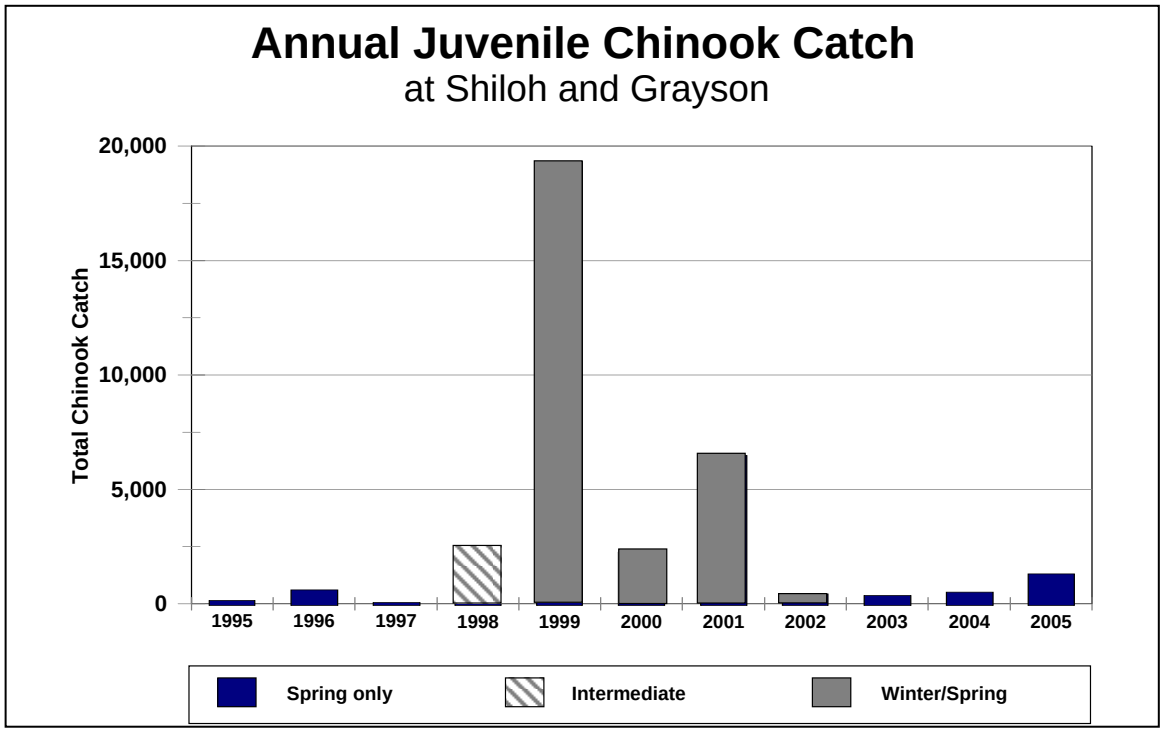

Figure 1. Annual number of juvenile Chinook salmon captured in the lower Tuolumne River at Shiloh (RM 3.4) and Grayson (RM 5.2) and sampling period type, 1995-2005.

The proportion of the typical outmigration period monitored each year ranged from 91% to 97% during winter/spring sampling years, from 24% to 40% during spring-only sampling years, and was 70% in the intermediate sampling year (Table 1). These proportions were calculated by taking the total number of sampling days in a given year and dividing by the total number of days for a typical complete outmigration period (i.e., January 1 through May 31).

The proportion of the outmigration period sampled may not be representative of the proportion of the juvenile population migrating during the sample period because migration timing can be influenced by environmental factors such as flow. For example, in years of low winter flows relatively few salmon reach the site prior to April (Figure 2). Under low flow conditions in 2002 (i.e., 265 cfs to 1,738 cfs) when sampling was conducted from January through early June, 94% of the juvenile Chinook catch occurred after April 1, yet this represented only 40% of the typical outmigration window. In contrast, most juveniles emigrated as fry from late January through early March during high flow years (i.e., flows exceeding 4,000 cfs at Modesto).

Changes in flow, particularly flow increases, were often associated with increased catches. Peak fry catches occurred at flows in excess of approximately 2,000 cfs. Fewer smolts appear to migrate after mid-May when flow often decreases to less than 1,000 cfs and water temperatures rise substantially. Smolts have been captured as late as June 17 (last day of sampling) during 2005 when flows remained relatively high through the late spring (i.e., greater than approximately 4,000 cfs), and water temperatures remained cooler than typical for that time of year.

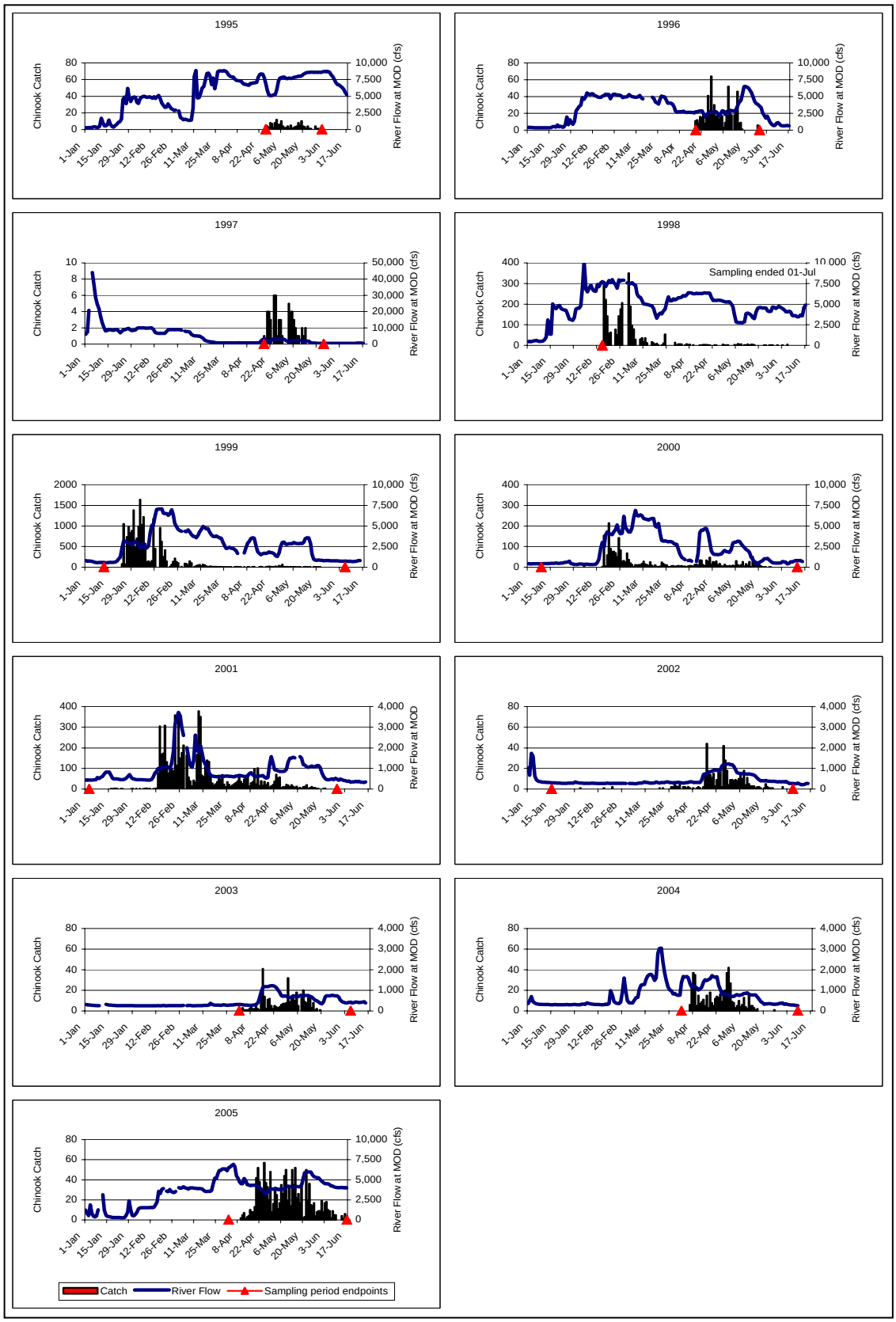

Figure 2. Daily Chinook catch at Shiloh/Grayson and river flow at Modesto, 1995-2005.

Trap Efficiency and Juvenile Chinook Abundance

Trap Efficiency

During all years except 2005, trap efficiency was estimated at Shiloh or Grayson by releasing known numbers of marked Chinook salmon from the Merced River Hatchery a short distance upstream of the trap (i.e., approximately one mile). The number of trap efficiency tests conducted annually ranged from 4 to 13 tests (Appendix B), with the number of tests generally dependent upon the number of weeks sampled. The proportion of marked fish recaptured from each group serves as an estimate of trap efficiency and these estimates are used to estimate juvenile Chinook abundance from daily trap catches. Generally this was done by developing regressions of trap efficiency and flows for each year to predict efficiency for all trapping days based on river flow measured at Modesto. There is some uncertainty about the accuracy of the estimates derived by this approach in that it does not account for the potential influence of turbidity and fish size on trap efficiency. Developing a model of trap efficiency or applying weekly trap efficiency estimates to the catch occurring during the same week may provide more accurate estimates.

In general, estimated efficiency at Shiloh and Grayson declined as river flow increased and was low and relatively consistent at flows greater than 1,000 cfs at Modesto (Figure 3 and Figure 4, Appendix B). Trap efficiency was consistently low at Shiloh from 1995 through 1998 (i.e., less than 4%) and this was one of the primary factors that contributed to the decision to move the trapping location to Grayson in 1999 (Figure 4, Appendix B). However, low trap efficiency at Shiloh may have been the result of high flows rather than the influence of the bridge piers upstream of the trap since results were similar between the two sites for tests conducted at comparable flows (i.e., greater than 1,000 cfs). Trap efficiency was more variable at Grayson, ranging from 0.5% to 21.2% from 1999 through 2004 (Figure 4, Appendix B), and this likely reflects differences in the range of flows and fish sizes evaluated at each site.

For example, at flows less than 1,000 cfs (Modesto gage) significant variability in trap efficiency was observed. This variability cannot be explained by flow alone, and there is some indication that fish size may account for some of this variability. The greatest range in trap efficiency occurred during 2002 when efficiency ranged between 0.5% and 21.2% at flows ranging from 280 cfs to 403 cfs. A regression of the average fish size and resulting trap efficiency for this subset of release events indicates a relatively strong relationship (R^2= 0.817; p=0.002) between fish size and trap efficiency where trap efficiency decreases as fish size increases.

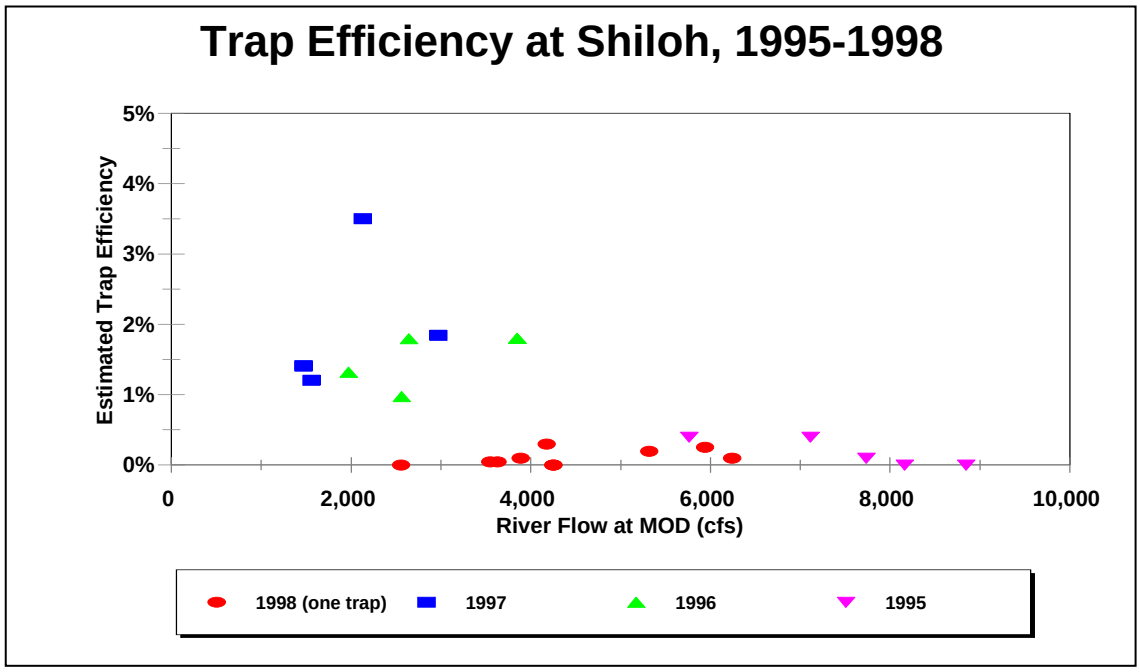

Figure 3. Estimated trap efficiency at Shiloh from 1995 through 1998.

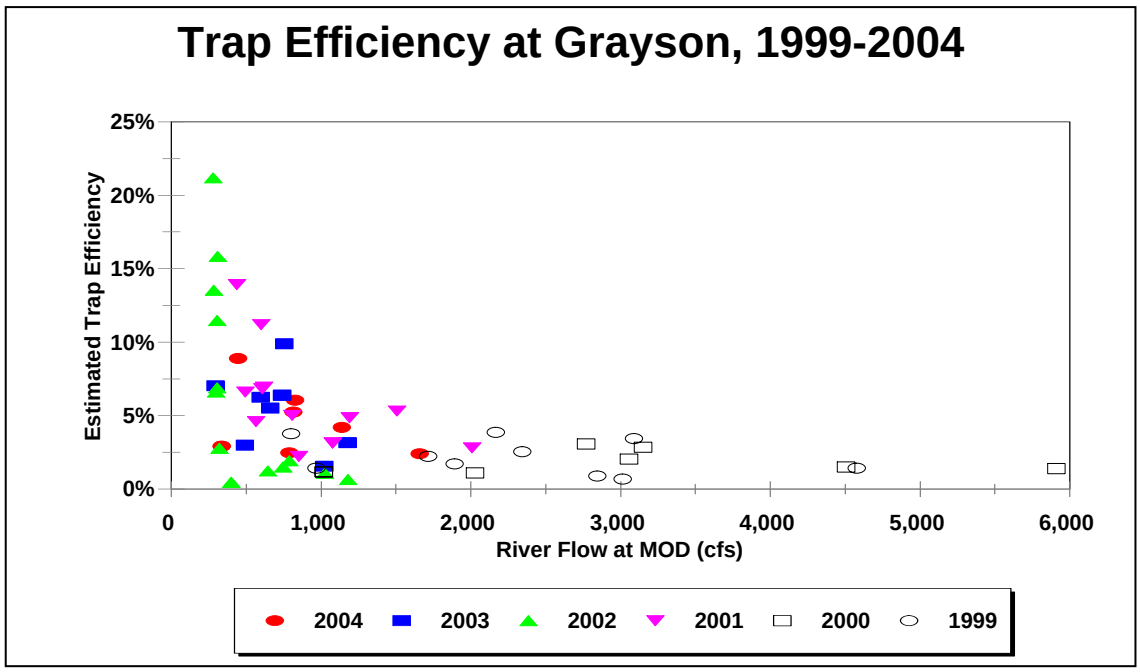

Figure 4. Estimated trap efficiency at Grayson from 1999 through 2004.

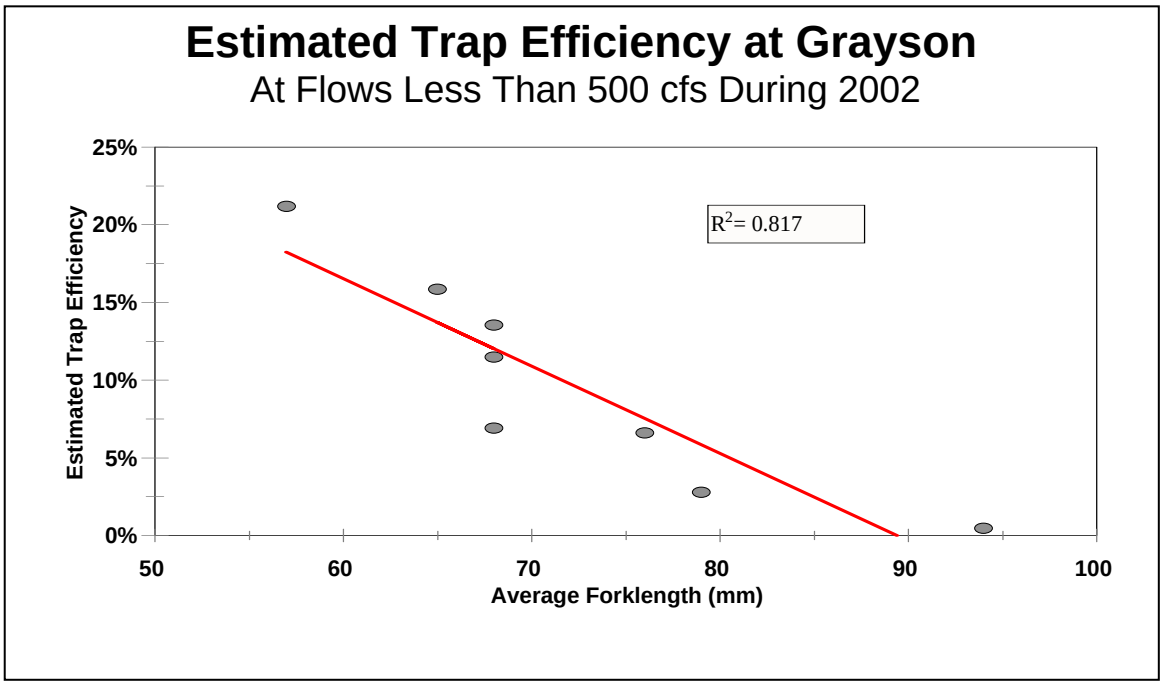

Figure 5. Estimated trap efficiency and average fish size at release at Grayson during 2002 for releases ranging from 280 cfs to 403 cfs.

Juvenile Chinook Abundance

Since sampling effort did not encompass the entire outmigration period in all years (Table 1, Figure 6), it is appropriate to describe expanded catches as estimated passage during the specific period sampled. Total estimated passage at Grayson during winter/spring sampling years ranged from a high of 1,073,669 during 1999 to a low of 14,540 during 2002 (Table 1, Figure 6). During spring-only sampling years at Grayson and Shiloh, estimated passage ranged from a high of 40,385 in 1996 to a low of 7,261 during 2003 (Table 1, Figure 6). Estimated passage was highest during 1998 (Table 1, Figure 6) when sampling effort was intermediate (i.e., February-July). However, the 1998 passage estimate may be inflated because no trap efficiency tests were conducted with fry. The regression equation for predicting daily trap efficiency during 1998 was based on tests conducted with larger fish and as described previously, there is a relatively strong relationship between fish size and trap efficiency. Therefore, the application of efficiencies predicted by this equation to fry captured during February could inflate estimated passage.

Comparison of trends in estimated daily Chinook passage between years and relative to environmental factors will be included in future reports when the data is available. At the time of this report, daily passage estimates are available for five of the eleven years sampled.

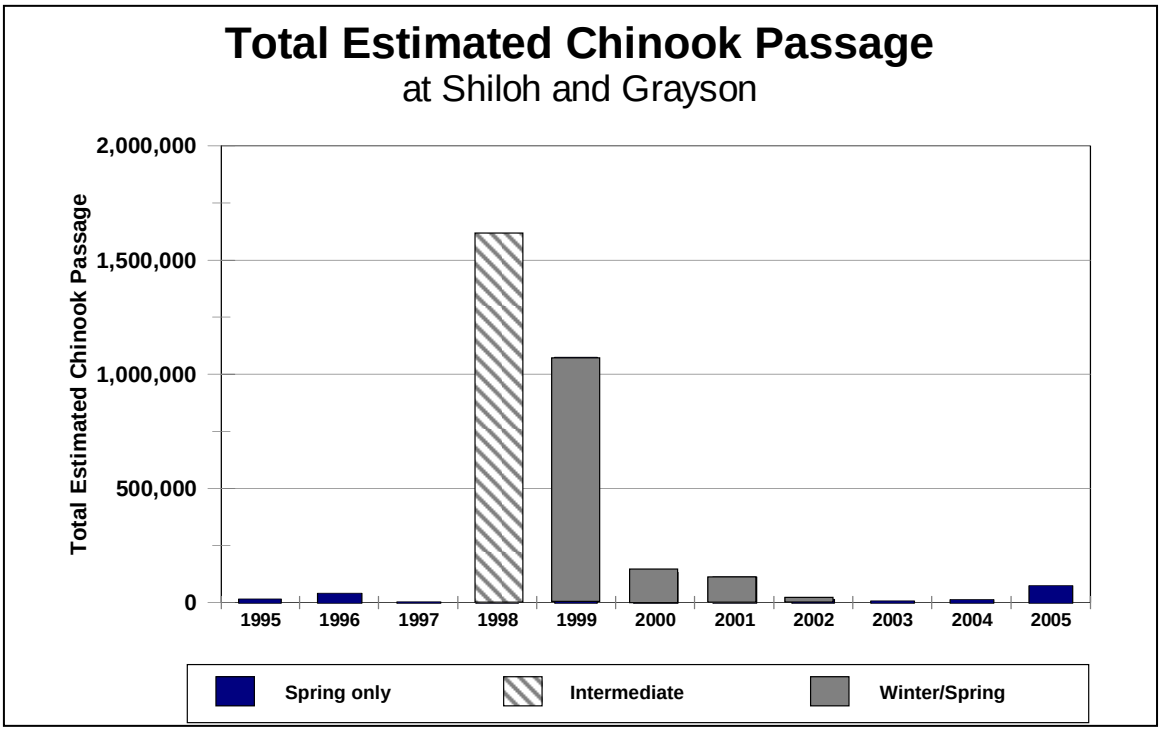

Figure 6. Total estimated Chinook passage and proportion of the typical outmigration period sampled annually at Shiloh and Grayson from 1995 through 2005.

Juvenile Chinook Emigration Timing

As described previously, juvenile Chinook outmigration in the San Joaquin Basin typically extends from January through May (Vasques and Kundargi 2001; SRFG 2004) and sampling effort was incomplete in many years. As such, timing of juvenile emigration can be compared among all years for the spring smolt period only. Since estimated daily passage data are not presently available for the 1999 and 2002 winter/spring sampling years, entire emigration timing can only be evaluated during 2000 and 2001.

Comparison of cumulative passage at Grayson during 2000 and 2001 indicates that migration timing was nearly identical in these two years, with few fish passing Grayson prior to February 15 or after mid-May (Figure 7). The majority of emigration occurred from mid-February through early March (fry) and from early April through mid-May (smolts), and passage was relatively low during most of March. Although this timing differs from the typical timing for the San Joaquin Basin in that few fish passed during January, high catches during 1999 suggests that passage may be high during January in some, but not all years.

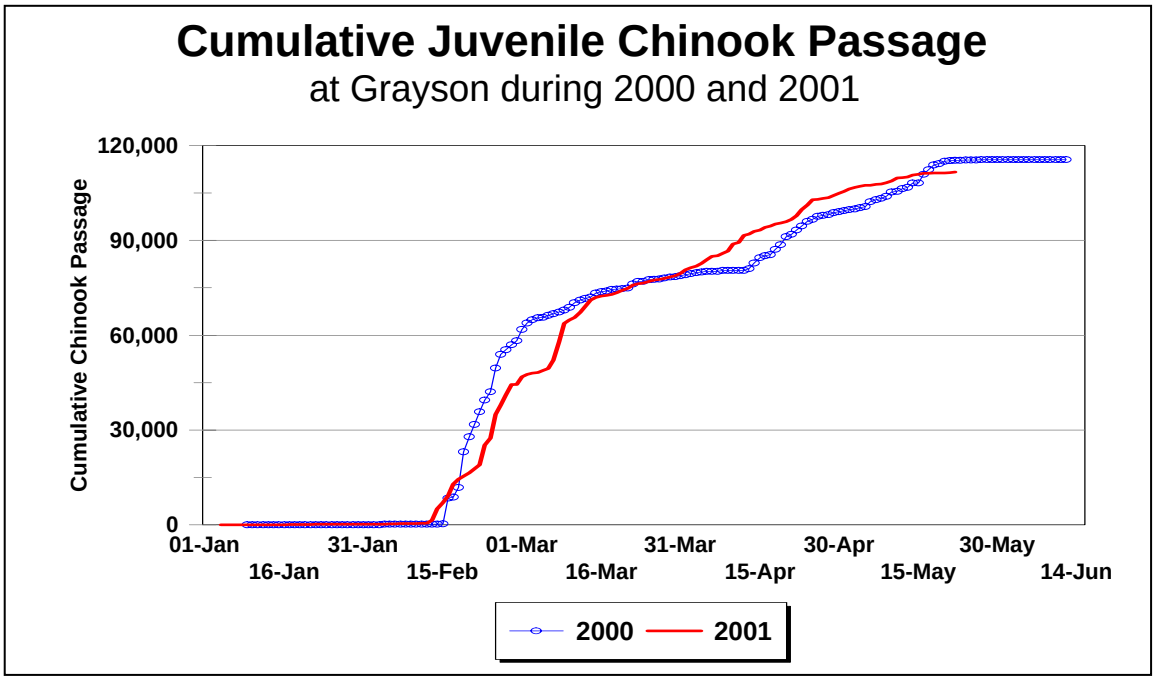

Figure 7. Cumulative estimated passage of juvenile Chinook salmon at Grayson (RM 5.2) during comprehensive sampling, 2000-2001. Data is not available for 1999 and 2002.

Size of Juvenile Chinook Outmigrants

Daily mean lengths of juvenile Chinook salmon captured at Shiloh/Grayson are presently available for 1997-2002 and 2004-2005 (Table 1). To simplify interannual comparison of how average Chinook length changes through the typical outmigration period, daily mean lengths were averaged per Julian week. The averages for some weeks were excluded due to low sample size.

Generally, average fish length was around 35-40 mm (forklength) during January and February then gradually increased to 90-100 mm by late May (Figure 8). From late March through early May, average size for a given week ranged widely between years. For example, during the week of April 2, average size differed by 25 mm from a low of 69 mm in 2000 to a high of 84 mm in 2002.

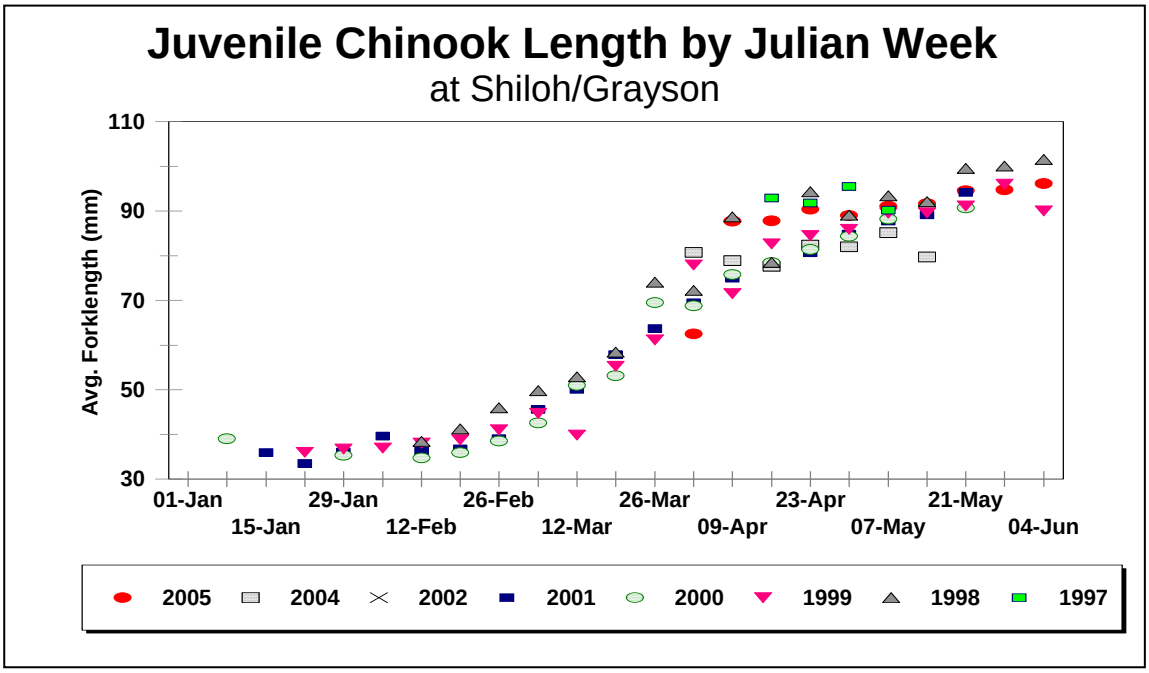

Figure 8. Weekly average forklengths of juvenile Chinook salmon captured at Shiloh (RM 3.4) and Grayson (RM 5.2), 1997-2002 and 2004-2005. Data is not available for 1995, 1996, and 2003.

Forklength data for individual juvenile Chinook salmon captured and measured at Shiloh and Grayson is available for 1998-2002 and 2004-2005 but is not presently available for 1995, 1996, 1997, and 2003. Therefore, length frequency distributions using available data were calculated for comparison. During years when lengths were sub-sampled (i.e., not all captured Chinook were measured), the length frequency distribution of measured fish on a given day was applied to the overall catch for the day.

Individual forklength data was available for the Grayson traps from 1999 through 2001 when sampling throughout the full season (i.e., winter/spring) occurred. The length frequency distributions for years (Figure 9) illustrate that juvenile Chinook catch was consistently dominated by fry (i.e., less than 50 mm) which represented 60% to 93% of the total annual catch. During 1999, only 7% of the fish captured were greater than 50 mm. In contrast, fish greater than 50 mm represented roughly one-third of the catch during 2000 and 2001. Less than 1% of the fish captured from 1999 through 2001 were greater than 100 mm.

Length frequency distributions of juvenile Chinook captured during April and May were also generated and compared for all years when data is available (i.e., 1998 through 2002 and 2004). These April/May distributions suggest that the dominant size class of smolts passing Shiloh/Grayson varies between years (Figure 10). During the years compared, peaks were observed in the 70-79 mm, 80-89 mm, and 90-99 mm classes. This trend will be further evaluated in future analyses.

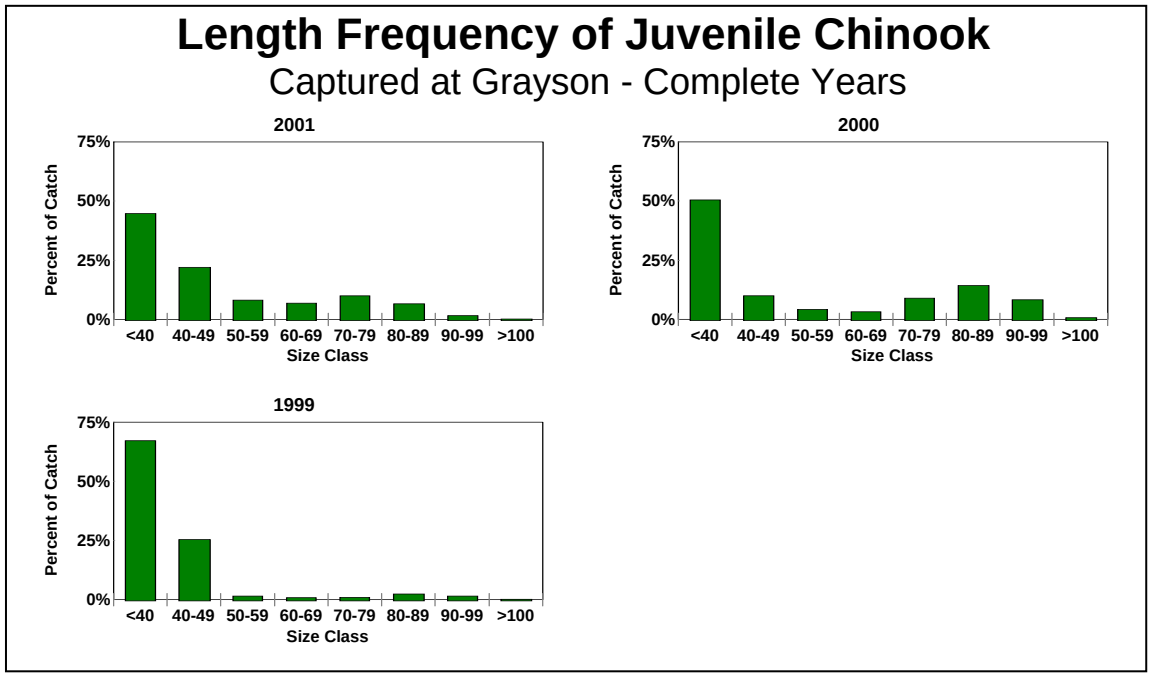

Figure 9. Length frequency distribution of juvenile Chinook captured at Grayson during 1999, 2000, and 2001 when sampling was complete.

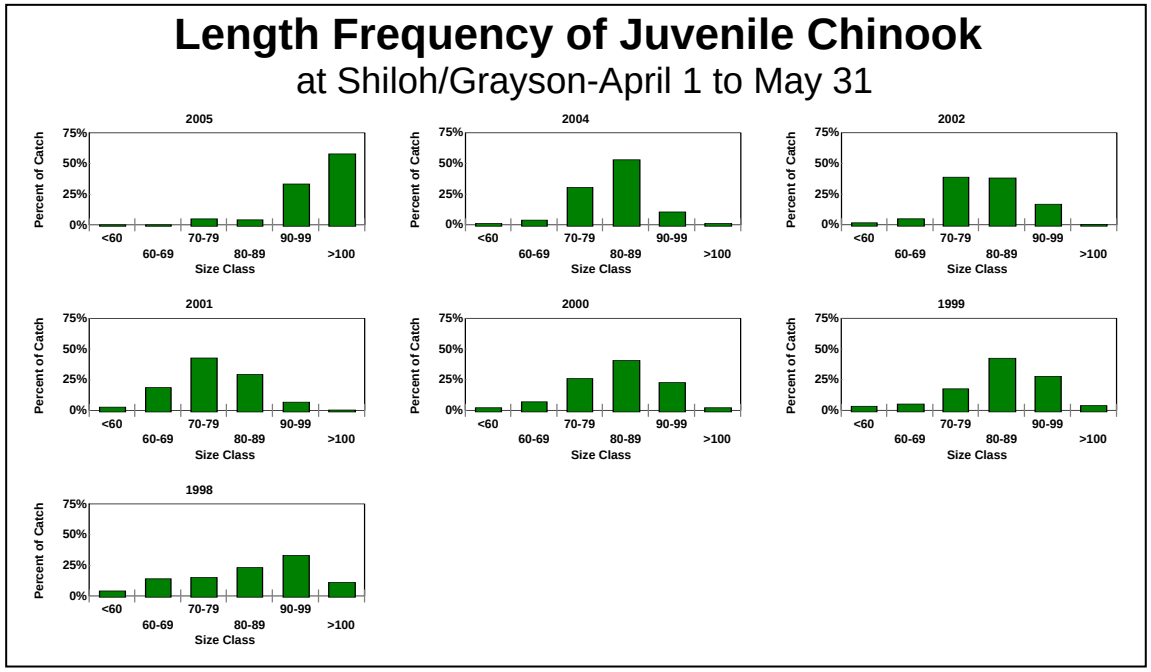

Figure 10. Length frequency distribution of juvenile Chinook captured from April 1 through May 31 at Shiloh during 1998 and at Grayson during 1999-2002 and 2004-2005.

Rainbow/steelhead trout

Over all years of outmigrant monitoring at Shiloh/Grayson, two rainbow/steelhead trout have been captured (Table 3).

Table 3. Rainbow/steelhead trout captured at Shiloh/Grayson from 1995 through 2005.

Date Captured	*Forklength (mm)*
2/21/2000	230 mm
5/14/2005	33 mm

Other Fish Species

Daily catch of species other than Chinook salmon is presently available for all years of monitoring at Shiloh and Grayson, with the exception of 1997. A total of 38 species have been represented in the catch (Table 4), including Chinook salmon. Of these, 29% are native to the Tuolumne River drainage and 71% are introduced species. Similarly, 23% (n=4,006) of the individuals captured have been native species and 77% (n=13,516) introduced, excluding Chinook salmon.

Over all years combined, white catfish were the most commonly captured species, followed by Pacific lamprey, largemouth bass, smallmouth bass, and bluegill (Table 4). Species rarely captured (i.e., fewer than 10 individuals captured) at Shiloh and Grayson include rainbow trout, brown bullhead, yellow bullhead, American shad, fathead minnow, hitch, hardhead, bigscale logperch, riffle sculpin, and striped bass.

Table 4. Species other than salmon captured at Shiloh 1995-1998 and at Grayson 1999-2005.

Common Name	*1995*	*1996*	*1997*	*1998*	*1999*	*2000*	*2001*	*2002*	*2003*	*2004*	*2005*	TOTAL
Catfish Family												
Bullhead catfish	0	2		0	0	0	0	0	0	0	0	**2**
Black bullhead	1	0		3	5	0	0	0	2	0	0	**11**
Brown bullhead	0	0		1	2	0	0	0	0	0	0	**3**
Channel catfish	1	1		8	15	61	28	12	12	12	3	**153**
White catfish	14	2		64	198	616	890	2,141	1,196	625	51	**5,797**
Yellow bullhead	0	0		1	0	0	0	0	0	0	0	**1**
Unidentified catfish	0	40		0	1	82	5	0	12	29	0	**169**
Herring Family												
American shad	0	0		1	0	4	0	2	0	1		**8**
Threadfin shad	0	1		46	4	312	85	43	13	3		**507**
Lamprey Family												
Pacific lamprey*	0	0		3	755	442	393	215	788	4	0	**2,600**
Unid. lamprey	0	0		0	0	0	172	76	0	4	13	**265**
Livebearer Family												
Mosquitofish	21	22		35	1	71	42	60	53	68	10	**383**
Minnow Family												
Carp	1	0		0	4	10	3	0	1	1	0	**20**
Fathead minnow	0	0		0	0	0	1	1	0	3	1	**6**
Hitch*	0	1		0	1	3	0	0	0	1	1	**7**
Golden shiner	2	11		0	6	144	105	5	14	5	10	**302**
Goldfish	32	12		75	5	6	1	3	0	0	2	**136**
Hardhead*	0	1		0	0	6	0	0	1	0	2	**10**
Red shiner	12	2		19	2	73	97	225	140	56	5	**631**
Sac. blackfish*	0	1		0	1	12	7	2	0	2	0	**25**
Sac. pikeminnow*	11	2		46	1	342	20	23	3	2	42	**492**
Sac. splittail*	0	0		0	2	12	1	3	2	0	0	**20**
Unid. minnow	570	0		0	7	93	26	10	4	0	0	**710**
Perch Family												
Bigscale logperch	0	0		0	0	0	1	3	0	0	0	**4**
Salmonid Family												
Rainbow trout*	0	0		0	0	1	0	0	0	0	1	**2**
Sculpin Family												
Prickly sculpin*	0	0		4	135	14	6	3	1	0	0	**163**
Riffle sculpin*	0	0		0	4	0	0	0	0	0	0	**4**
Unidentified sculpin	0	3		0	0	0	0	0	0	0	0	**3**
Silverside Family												
Inland silverside	3	102		18	7	92	55	48	19	15	5	**364**
Smelt Family												
Wakasagi	0	0		19	0	0	0	0	0	0	0	**19**
Sucker Family												
Sacramento sucker*	39	12		2	94	114	126	58	12	17	4	**478**
Sunfish Family												
Bass- unid. species	0	0		0	0	0	0	0	0	29	0	**29**
Black crappie	0	0		0	41	1	2	66	0	0	0	**110**
Bluegill	1	26		8	80	431	446	168	16	37	19	**1,232**
Green sunfish	2	2		0	7	8	5	8	10	2	0	**44**
Largemouth bass	2	56		2	26	264	137	474	0	638	15	**1,614**
Redear sunfish	0	0		1	1	4	2	3	1	0	1	**12**
Red-eye bass	0	0		0	0	1	0	0	0	0	0	**1**
Smallmouth bass	0	0		1	2	58	40	510	17	785	6	**1,419**
Spotted bass	0	0		0	0	33	0	125	2	0	0	**160**
Warmouth	0	1		15	2	8	1	9	2	0	1	**38**
White crappie	0	3		0	21	10	5	1	1	0	0	**41**
Unidentified sunfish	3	2		8	4	42	17	30	306	8	0	**420**
Surfperch Family												
Tule Perch	0	0		0	0	0	0	0	0	0	1	**1**
Temperate Bass Family												
Striped bass	0	0		0	2	4	0	1	0	0	0	**7**

* Indicates species native to the Tuolumne River.

LITERATURE CITED

Blakeman, D. 2004a. 1998 juvenile Chinook salmon capture and production indices using rotary-screw traps on the lower Tuolumne River. California Department of Fish and Game, Technical report submitted to Tuolumne River Technical Advisory Committee, Turlock, CA.

Blakeman, D. 2004b. 2002 juvenile Chinook salmon capture and production indices using rotary-screw traps on the lower Tuolumne River. California Department of Fish and Game, Technical report submitted to Tuolumne River Technical Advisory Committee, Turlock, CA.

Blakeman, D. 2004c. 2003 juvenile Chinook salmon capture and production indices using rotary-screw traps on the lower Tuolumne River. California Department of Fish and Game, Technical report submitted to Tuolumne River Technical Advisory Committee, Turlock, CA.

Fuller, A.N. 2005. Outmigrant trapping of juvenile salmonids in the lower Tuolumne River at Grayson 2004. S.P. Cramer & Associates, Gresham, OR. Final Report submitted to Turlock and Modesto Irrigation Districts.

Fuller, A.N., M. Simpson, and C. Sonke. 2006. Outmigrant trapping of juvenile salmonids in the lower Tuolumne River at Grayson 2005. S.P. Cramer & Associates, Gresham, OR. Final Report submitted to Turlock and Modesto Irrigation Districts.

Heyne, T. and W. Loudermilk. 1997. Rotary screw trap capture of Chinook salmon smolts on the Tuolumne River in 1995 and 1996: Contribution of assessment of survival and production estimates. Federal Energy Regulatory Commission annual report, FERC project #2299-024.

Heyne, T. and W. Loudermilk. 1998. Rotary screw trap capture of Chinook salmon smolts with survival and production indices for the Tuolumne River in 1997. Federal Energy Regulatory Commission annual report, FERC project #2299-024.

Stanislaus River Fish Group. 2004. A summary of Fisheries Research in the Lower Stanislaus River. Working Draft. March 2004. Available on the SRFG website at http://www.delta.dfg.ca.gov/srfg/

Vasques, J. and K. Kundargi. 2002. 2001 Juvenile Chinook capture and production indices using rotary screw traps on the lower Tuolumne River. California Department of Fish and Game, San Joaquin Valley Southern Sierra Region, Anadromous Fisheries Program.

Vasques, J. and K. Kundargi. 2001. 1999-2000 Grayson Screw Trap Report. California Department of Fish and Game Anadromous Fisheries Project, San Joaquin Valley Southern Sierra Region (Region 4). March 2001.

Appendix A. Presently available information for daily Chinook catch, mean length, and passage at Shiloh and Grayson from 1995 through 2005.

	Daily Catch of Chinook Salmon											Daily Chinook Mean Length (mm)								Estimated Chinook Passage				
Date	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	1997	1998	1999	2000	2001	2002	2004	2005	1997	2000	2001	2004	2005
01-Jan																								
02-Jan																								
03-Jan																								
04-Jan							1									86.0						29		
05-Jan																								
06-Jan																								
07-Jan																								
08-Jan																								
09-Jan																					0			
10-Jan						1									39.0						53			
11-Jan																					0			
12-Jan																					0			
13-Jan																					0			
14-Jan																					0			
15-Jan																								
16-Jan							2									36.5					0	23		
17-Jan							1									37.0					0	11		
18-Jan							3									36.0					0	33		
19-Jan							3									34.0					0	32		
20-Jan							1									36.0					0	11		
21-Jan																					0			
22-Jan							2									33.0						21		
23-Jan					79		1							35.4		34.0					0	11		
24-Jan					1050									35.0							0			
25-Jan					75									36.3							0			
26-Jan					735									36.2							0			
27-Jan					980									36.1							0			
28-Jan					829		1							36.8		140.0					0	1		
29-Jan					890		2							37.2		39.0						23		
30-Jan					1386									36.4							0			
31-Jan					480		2							36.5		36.0					0	22		
01-Feb					698			1						36.9			37				0			

Date	Daily Catch of Chinook Salmon											Daily Chinook Mean Length (mm)								Estimated Chinook Passage				
	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	1997	1998	1999	2000	2001	2002	2004	2005	1997	2000	2001	2004	2005
02-Feb					993		2							36.4		35.0					0	22		
03-Feb					1642									36.5							0			
04-Feb					1030	3	1							36.9	35.3	34.0					158	11		
05-Feb					1222		2							37.7		44.5						24		
06-Feb					568		4							36.2		77.7					0	90		
07-Feb					130		1							37.0		35.0					0	11		
08-Feb					147		2							36.3		36.5					0	22		
09-Feb					116									36.6							0			
10-Feb					155		1							37.0		103.0					0	72		
11-Feb					1168		2							38.0		42.5					0	25		
12-Feb					450		4							39.2		36.8						47		
13-Feb							77									36.5					0	917		
14-Feb							305									36.0					0	3595		
15-Feb					956	3	169	1						37.4	34.0	36.0	37				158	2025		
16-Feb				309	620	154	173						37.9	37.5	34.6	36.5					8108	2090		
17-Feb				221	257	5	308						38.4	37.9	34.0	35.7					263	3682		
18-Feb				142	418	59	132						39.0	38.1	36.4	36.0					3107	1589		
19-Feb				59	147	214	77						40.1	37.6	36.1	35.7					11269	920		
20-Feb				63		90	97	2					37.8		35.5	35.9	83				4739	1146		
21-Feb					16	75	98							38.3	35.1	35.4					3949	1208		
22-Feb					65	76	88							40.4	35.9	38.7					4002	1240		
23-Feb				77	136	69	358						45.2	38.9	35.3	36.6					3634	6233		
24-Feb				50	213	50	115						39.3	39.2	37.3	36.9					2633	2229		
25-Feb				142	133	142	362						43.9	38.3	36.3	37.9					7478	7518		
26-Feb				175	103	83	150						44.6	38.4	35.6	37.4					4371	2975		
27-Feb				206		28	177						46.2		36.2	38.9					1474	3105		
28-Feb					18	31	212							41.6	36.5	39.0					1633	3440		
29-Feb						24									41.8						1264			
01-Mar					87	68	164							40.0	41.2	38.5					3581	2355		
02-Mar				350	86	37	57						47.6	41.2	39.9	37.9					1948	746		
03-Mar				189	46	20	39						45.7	39.5	39.1	41.0					1053	505		
04-Mar				97	144	13	15						45.7	45.3	37.4	40.5					685	191		
05-Mar				78	105	1	42						48.0	43.0	34.0	45.2					53	602		
06-Mar				28		12	32						47.0		44.3	49.0					632	660		
07-Mar					18	10	167							47.8	49.8	44.5					527	2592		

Date	Daily Catch of Chinook Salmon											Daily Chinook Mean Length (mm)								Estimated Chinook Passage				
	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	1997	1998	1999	2000	2001	2002	2004	2005	1997	2000	2001	2004	2005
08-Mar					35	11	378							43.6	42.4	44.4					579	5787		
09-Mar				29	47	11	351						50.6	48.3	41.7	46.1					579	5887		
10-Mar				35	55	17	67						50.7	44.4	42.8	44.5					895	1014		
11-Mar				17	24	28	60						52.5	41.2	43.2	45.4					1475	868		
12-Mar				36	68	15	109						51.0	39.6	44.1	47.6					790	1560		
13-Mar				11	52	11	140						53.7	38.2	46.8	50.7					579	2061		
14-Mar					26	7	133							37.6	48.4	48.8					369	1828		
15-Mar					11	25	64							41.9	55.9	49.5					1317	870		
16-Mar				17	19	8	28						54.4	36.4	54.8	49.7					421	379		
17-Mar				12	20	3	18						57.3	45.3	45.3	49.8					158	244		
18-Mar				5	9	10	24						48.2	39.4	61.3	54.3					527	340		
19-Mar				8	14	3	35	1					51.4	50.6	48.3	55.4	64				158	515		
20-Mar				1	11	2	52						55.0	55.6	45.5	54.9					105	762		
21-Mar					13	4	45	1						53.5	50.5	53.6	105				211	652		
22-Mar				1	11	24	69						58.0	46.2	56.0	58.2					1264	1063		
23-Mar				10	10	17	23						64.6	56.5	53.2	61.4					895	377		
24-Mar				53	5	12	10						62.9	55.2	59.2	59.9						161		
25-Mar					3	10	34							69.0	58.8	61.3					527	562		
26-Mar					7	2	22	2						61.9	87.0	64.8	95.5				105	386		
27-Mar					6	1	13	2						48.0	45.0	64.2	75				53	232		
28-Mar					3	6	19	6						66.0	62.3	62.6	81.17				316	319		
29-Mar					7	6	25	3						72.0	69.8	61.2	88.67				316	407		
30-Mar				14	2	3	30	2					70.8	50.0	72.7	61.4	77.5				158	497		
31-Mar				1	3	5	38	5					84.0	61.7	74.8	64.8	76.2				263	669		
01-Apr				6	10	7	64						67.3	68.3	74.7	66.8					369	1170		
02-Apr				6	12	5	37	2	1	0	2		69.2	69.3	57.8	64.9	76		62.5		263	664		208
03-Apr				5	3	6	26	2	3				73.0	76.0	67.2	66.0	90				316	477		0
04-Apr					6	4	47	1	1					80.7	77.8	70.1	104				211	913		0
05-Apr				1	2	4	56	2	1				82.0	54.5	57.7	69.5	79				211	1089		0
06-Apr				6	4	2	55	1	1	6	0		66.0	81.5	72.5	68.3	75	83.7	-			1058	171	0
07-Apr				3	1	5	14		2	24	0		72.7	98.0	76.6	72.2		78.3	-			305	611	0
08-Apr				4	3	7	29	1	4	37	0		70.3	85.3	72.0	74.8	80	80.2	-		368	686	976	0
09-Apr					4	6	35		2	35	0			80.5	81.8	74.3		80.7	-			785	902	0
10-Apr				2	1	4	98	1	2	5	2		70.0	69.0	72.8	74.4	94	80.0	82.5			2138	125	121
11-Apr					10	13	24	2	5	15	5			66.1	74.8	75.4	88.5	79.5	85.2			529	351	301

	Daily Catch of Chinook Salmon											Daily Chinook Mean Length (mm)								Estimated Chinook Passage				
Date	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	1997	1998	1999	2000	2001	2002	2004	2005	1997	2000	2001	2004	2005
12-Apr					8	14	101	1	2	7	7			79.3	72.9	76.6	79	75.4	87.4			2300	170	489
13-Apr					1	9	16		1	9	1			72.0	73.1	72.9		77.2	92.0		474	347	227	66
14-Apr				1	1	34	40	2	13	11	3		100.0	61.0	76.6	75.7	85	80.9	90.7		1790	894	326	177
15-Apr				1	3	33	17	13	41	5	4		96.0	72.3	78.0	75.3	77.08	78.0	88.3		1738	383	160	235
16-Apr				3	14	11	37	44	14	15	10		90.3	77.4	74.2	75.6	75.94	84.4	88.9		579	815	467	578
17-Apr				3	5	6	20	16	2	3	8		89.0	87.6	79.3	76.4	74.93	85.0	87.7		316	448	97	466
18-Apr		11	1	3	2	33	30	14	11	18	8	93.0	84.0	78.5	81.4	77.6	80.09	78.8	87.6	64	1738	696	603	467
19-Apr		12	0	2	7	28	9	11	12	8	13		83.0	83.7	79.8	76.4	76.1	55.5	90.1	0	1474	254	300	760
20-Apr		8	4	1	16	47	15	15	5	5	42	98.8	46.0	81.1	79.0	77.8	77.67	79.0	86.5	262	2475	494	180	2436
21-Apr		16	4		21	14	21	3	2	12	52	89.8		84.6	76.5	83.2	71	79.8	86.1	209	737	726	421	2912
22-Apr		15	3		11	26	38	9	5	14	38	90.0		85.3	78.6	80.3	80.56	80.9	87.4	160	1369	1099	504	2084
23-Apr		19	0	2	12	24	71	16	4	13	28		82.5	82.3	78.9	80.4	75.85	84.7	90.3	0	1263	1958	347	1505
24-Apr		8	6	1	11	29	54	17	3	16	30	88.3	104.0	86.1	80.4	78.9	78.19	80.3	88.5	392	1527	1395	383	1558
25-Apr		19	6		19	12	57	2	4	9	57	97.5		80.9	81.1	81.1	77.5	88.2	90.1	392	632	1685	190	2807
26-Apr	5	41	1		9	17	6	42	6	19	37	88.0		86.6	78.4	79.7	81.79	78.6	90.9	66	895	163	394	1766
27-Apr	4	23	3		39	6	10	28	7	20	33	78.3		85.0	82.5	80.4	84.75	82.1	90.5	197	316	281	426	1642
28-Apr	2	64	3	4	28	4	10	18	7	37	20	95.3	93.8	85.0	82.5	80.8	80.6	82.2	91.2	197	211	282	786	1059
29-Apr	8	18	1	1	67	13	22	4	8	42	48	103.0	97.0	85.4	85.8	83.1	74	80.2	91.2	65	684	701	889	2575
30-Apr	7	30	0	1	13	6	19	9	32	27	8		90.0	88.8	82.0	82.6	85.62	81.7	90.5	0	316	679	542	428
01-May	2	16	0	2	9	5	12	9	9	9	16		89.5	85.0	82.6	85.1	85.33	81.1	88.7	0	263	539	181	857
02-May	8	20	0		9	7	20	8	13	8	30			86.4	84.4	82.4	86	83.0	92.1	0	369	819	161	1636
03-May	12	13	5		3	5	13	9	13	3	25	96.2		86.7	83.2	84.4	83.44	83.7	87.1	247	263	446	62	1341
04-May	6	18	4		11	8	7	8	10	5	11	88.5		89.2	83.6	84.7	82.62	80.0	85.6	200	421	313	105	579
05-May	6	17	4	3	4	6	13	10	18	10	17	99.8	87.7	82.3	88.0	88.9	85.12	84.3	87.4	228	316	331	206	909
06-May	10	3	3	1	8	30	3	14	5	4	35	97.3	89.0	82.6	86.6	85.3	89.43	79.8	91.7	174	1580	72	83	1874
07-May	4	9	2	7	6	12	7	10		6	26	91.5	93.7	93.8	87.6	84.8	83.7	84.5	91.3	115	632	324	126	1390
08-May	2	23	1	5	5	7	2	18	13	13	44	95.0	92.2	85.2	86.9	81.5	88.4	84.1	90.3	57	369	76	279	2356
09-May	2	52	1	5	6	12	10	4	20	4	50	85.0	92.0	88.8	86.4	87.3	83.33	80.0	93.9	57	632	421	87	2795
10-May	4	23	0		4	26	13	11	9	2	19			86.5	87.0	86.9	86.56	85.0	91.4	0	1369	541	44	1087
11-May	1	18	2	2	1	4	20	5	8	16	34	84.5	90.5	94.0	87.5	89.9	82.6	88.6	92.8	115	211	898	339	1930
12-May	5		1	2	5	16	2	3	13	5	14	92.0	95.0	90.6	90.5	93.0	90	85.0	86.3	52	842	105	104	795
13-May	1	18	2	5	8	8	6	3	12	5	50	93.0	97.0	87.5	91.3	90.4	86.33	88.8	90.7	101	421	279	104	2816
14-May	2	25	0	1	3	26	11	3	3	3	35		90.0	86.7	92.2	91.0	85.67	82.0	91.9	0	1369	563	63	1975
15-May	3	46	0	4	3	1	6	1	8	1	52		89.8	88.7	88.0	89.0	102	80.0	93.3	0	53	258	21	2929
16-May	4	8	0	4	6	51	6	2	1	2	22		93.0	89.6	91.1	88.0	97	77.0	94.3	0	2685	253	40	1244

Daily Catch of Chinook Salmon

Date	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005
17-May	8	9	0	2	2	29	2	2	2	0	26
18-May	5	1	0		9	27	2	1		0	17
19-May	10		0		7	9			1	0	36
20-May	4		0		6	13		1		0	2
21-May	3	0	0		3	5	2	5		0	3
22-May	1		0		3	1	4	2		0	50
23-May	4		0	1	1	1		1		0	20
24-May	1		0	1	2	1		1		0	36
25-May	1				1			1		0	15
26-May	0			1	2	1				1	14
27-May	0			1		1				0	17
28-May	4	6		1	1					0	4
29-May	1	1									8
30-May	1										9
31-May	0			1				2			9
01-Jun	0				1					0	19
02-Jun										0	8
03-Jun				1						0	17
04-Jun										0	18
05-Jun					1					0	10
06-Jun				4	2					0	9
07-Jun										0	2
08-Jun										0	9
09-Jun										0	5
10-Jun											5
11-Jun											
12-Jun											
13-Jun											
14-Jun											4
15-Jun											1
16-Jun											6
17-Jun											2

Daily Chinook Mean Length (mm)

1997	1998	1999	2000	2001	2002	2004	2005
	95.5	94.5	92.1	83.5	86.5		92.5
		91.4	93.3	94.0	91		93.4
		88.4	90.5				90.5
		87.7	89.6		82		85.0
		93.7	89.0	91.0	85.75		95.0
		85.3	90.0	97.3	85.5		93.2
	96.0	86.0	92.0		90		93.3
	104.0	92.5	90.0		112		94.2
		93.0			89		96.9
	98.0	96.0	96.0			87.0	94.1
	100.0		87.0				95.2
	98.0	100.0					93.8
							97.6
							96.3
	99.0						96.2
		92.0					96.0
							98.9
	103.0						84.4
							94.3
		89.0					98.5
	101.5	91.0					100.3
							91.0
							96.1
							94.6
							97.6
							100.0
							80.0
							94.8
							96.5

Estimated Chinook Passage

1997	2000	2001	2004	2005
0	1526	70	0	1467
0	1421	119	0	959
0	474		0	2143
0	684		0	144
0	263	74	0	257
0	53	186	0	4376
0	53		0	1771
0	53		0	3188
	0		0	1317
	53		17	1110
	53		0	1272
	0		0	294
	0		ns	577
	0		ns	644
	0		ns	608
	0		0	1222
	0		0	496
	0		0	1024
	0		0	1078
	0		0	599
	0		0	525
	0		0	113
	0		0	505
	0		0	275
	0			272
	0			0
	0			0
				0
				216
				53
				322
				107

Appendix B. Trap efficiency releases conducted at Shiloh and Grayson, 1995-2004.

Release Date	Origin	Mark	Release Time	Number Released	Number Recaptured	% Recaptured	Length at Release (mm)	Length at Recap. (mm)	Flow (cfs) at MOD
GRAYSON									
13-Apr-04	Hatchery	Dorsal fin green	2030	1992	84	4.2%	79	74	1140
20-Apr-04	Hatchery	Anal fin green	2000	1980	48	2.4%	81	79	1660
27-Apr-04	Hatchery	Top caudal green	2020	1941	118	6.1%	86	85	826
04-May-04	Hatchery	Bottom caudal green	2030	2008	50	2.5%	90	87	789
11-May-04	Hatchery	Anal fin green	2040	1972	104	5.3%	86	79	815
18-May-04	Hatchery	Dorsal fin green	2045	1996	178	8.9%	88	77	446
25-May-04	Hatchery	Top caudal green	2045	2013	59	2.9%	92	90	337
10-Apr-03	Hatchery	Top caudal green	NP	1956	138	7.1%	77	NP	294
17-Apr-03	Hatchery	Bottom caudal green	NP	2047	65	3.2%	77	NP	1178
24-Apr-03	Hatchery	Anal fin green	NP	1979	31	1.6%	88	NP	1022
01-May-03	Hatchery	Dorsal fin green	NP	2044	113	5.5%	96	NP	662
08-May-03	Hatchery	Top caudal green	NP	2078	206	9.9%	83	NP	755
15-May-03	Hatchery	Bottom caudal green	NP	1996	125	6.3%	83	NP	598
20-May-03	Hatchery	Anal fin green	NP	1989	60	3.0%	89	NP	491
28-May-03	Hatchery	Dorsal fin green	NP	1950	125	6.4%	94	NP	740
20-Feb-02	Hatchery	Bottom caudal red	NP	2094	444	21.2%	57		280
06-Mar-02	Hatchery	Anal fin red	NP	2331	316	13.6%	68		283
13-Mar-02	Hatchery	Top caudal red	NP	2042	324	15.9%	65		311
20-Mar-02	Hatchery	Dorsal fin red	NP	2105	242	11.5%	68		307
27-Mar-02	Hatchery	Bottom caudal red	NP	2121	147	6.9%	68		307
03-Apr-02	Hatchery	Anal fin red, ad-clip	NP	1962	130	6.6%	76		298
09-Apr-02	Hatchery	Top caudal red, ad-clip	NP	1995	56	2.8%	79		322
17-Apr-02	Hatchery	Dorsal fin red, ad-clip	NP	2048	40	2.0%	84		788
25-Apr-02	Hatchery	Bottom caudal red, ad-clip	NP	2001	22	1.1%	86		1027
01-May-02	Hatchery	Anal fin red, ad-clip	NP	2033	14	0.7%	89		1182
08-May-02	Hatchery	Dorsal fin red, ad-clip	NP	2021	31	1.5%	95		746
15-May-02	Hatchery	Top caudal red, ad-clip	NP	2047	26	1.3%	97		645
22-May-02	Hatchery	Bottom caudal red, ad-clip	NP	2043	10	0.5%	94		403
18-Jan-01	Hatchery	Top caudal blue	NP	1810	120	6.6%	37		496
08-Feb-01	Hatchery	Bottom caudal blue	NP	1980	276	13.9%	47		438
01-Mar-01	Hatchery	Top caudal yellow	NP	2017	57	2.8%	41		2010
14-Mar-01	Hatchery	Bottom caudal yellow	NP	1487	75	5.0%	46		807
21-Mar-01	Hatchery	Bottom caudal blue, Dorsal fin blue, Top caudal yellow	NP	3025	207	6.8%	61		607
28-Mar-01	Hatchery	Anal fin blue	NP	1954	219	11.2%	51		602
11-Apr-01	Hatchery	Bottom caudal yellow, ad-clip	NP	2021	141	7.0%	66		621
18-Apr-01	Hatchery	Top caudal blue, ad-clip	NP	2060	95	4.6%	68		566
25-Apr-01	Hatchery	Dorsal fin yellow, Bottom caudal blue, Dorsal fin blue, ad-clip	NP	1515	34	2.2%	71		853
02-May-01	Hatchery	Anal fin blue, ad-clip	NP	3053	163	5.3%	72		1507
09-May-01	Hatchery	Bottom caudal yellow,	NP	3002	147	4.9%	75		1192

Release Date	Origin	Mark	Release Time	Number Released	Number Recaptured	% Recaptured	Length at Release (mm)	Length at Recap. (mm)	Flow (cfs) at MOD
		ad-clip							
16-May-01	Hatchery	Top caudal blue, ad-clip	NP	2942	93	3.2%	76		1078
01-Mar-00	Hatchery	Top caudal blue	NP	1964	30	1.5%	56	53	4506
16-Mar-00	Hatchery	Bottom caudal blue	NP	1548	22	1.4%	56	56	5912
23-Mar-00	Hatchery	Anal fin blue	NP	1913	55	2.9%	59	60	3151
30-Mar-00	Hatchery	Top caudal blue	NP	1942	60	3.1%	62	63	2772
29-Apr-00	Hatchery	Top caudal blue, ad-clip	NP	1931	22	1.1%	81	82	2027
06-May-00	Hatchery	Bottom caudal blue, ad-clip	NP	1987	41	2.1%	85	85	3057
24-May-00	Hatchery	Top caudal blue, ad-clip	NP	2010	24	1.2%	85	85	1018
11-Mar-99	Hatchery	Anal fin blue	NP	1946	28	1.4%	54	53	4578
24-Mar-99	Hatchery	Bottom caudal blue, ad-clip	NP	1938	67	3.5%	61	61	3091
31-Mar-99	Hatchery	Top caudal blue, ad-clip	NP	1885	73	3.9%	65	64	2167
07-Apr-99	Hatchery	Bottom caudal blue, ad-clip	NP	1949	50	2.6%	68	68	2345
14-Apr-99	Hatchery	Anal fin blue, ad-clip	NP	1953	34	1.7%	73	72	1893
20-Apr-99	Hatchery	Top caudal blue, ad-clip	NP	2007	45	2.2%	73	75	1714
29-Apr-99	Hatchery	Bottom caudal blue, ad-clip	NP	1959	14	0.7%	79	80	3015
04-May-99	Hatchery	Anal fin blue, ad-clip	NP	2008	18	0.9%	83	82	2845
18-May-99	Hatchery	Top caudal blue, ad-clip	NP	2001	29	1.4%	86	84	969
26-May-99	Hatchery	Bottom caudal blue, ad-clip	NP	1984	75	3.8%	96	92	799
SHILOH									
18-Mar-98	Hatchery	Top caudal blue	NP	1956	2	0.1%	57	57	3890
02-Apr-98	Hatchery	Bottom caudal blue	NP	2005	2	0.1%	66	66	6240
08-Apr-98	Hatchery	Anal fin blue	NP	1962	5	0.3%	71	71	5940
15-Apr-98	Hatchery	Bottom caudal red	NP	2000	4	0.2%	77	77	5320
22-Apr-98	Hatchery	Top caudal red	NP	1998	6	0.3%	79	79	4180
29-Apr-98	Hatchery	Anal fin red	NP	1979	1	0.1%	85	85	3630
06-May-98	Hatchery	Bottom caudal red	NP	1955	0	0.0%	89	89	2560
14-May-98	Hatchery	Top caudal red	NP	1975	1	0.1%	88	88	3550
27-May-98	Hatchery	Anal fin red	NP	2000	0	0.0%	95	95	4250
21-Apr-97	Hatchery	Top caudal blue	NP	2149	26	1.2%	63	63	1560
28-Apr-97	Hatchery	Bottom caudal blue	NP	2001	37	1.8%	67	68	2970
05-May-97	Hatchery	Anal fin blue	NP	1995	70	3.5%	66	67	2130
12-May-97	Hatchery	Top caudal blue	NP	1487	21	1.4%	66	67	1470
24-Apr-96	Hatchery	NP	NP	2038	27	1.3%	NP	64	1972
30-Apr-96	Hatchery	NP	NP	2164	39	1.8%	NP	70	2647
08-May-96	Hatchery	NP	NP	2147	21	1.0%	90	76	2566
15-May-96	Hatchery	NP	NP	2105	38	1.8%	80	79	3850
25-Apr-95	Hatchery	NP	NP	1000	4	0.4%	72	78	7113
02-May-95	Hatchery	NP	NP	999	4	0.4%	80	73	5768
11-May-95	Hatchery	NP	NP	1003	1	0.1%	82	77	7735
18-May-95	Hatchery	NP	NP	2000	0	0.0%	85	NP	8164
25-May-95	Hatchery	NP	NP	2000	0	0.0%	89	NP	8845